A REVIEW OF ASTRONOMY IN 1914.

By R. T. Crawford.

At the close of a year in which our Society makes an award of the Bruce Gold Medal the subject for the address of the retiring President is easily fixed in that the address is a setting forth of the reasons for making the award. At this time, however, altho such an award has been made, the Directors of the Society have ordered that the *de facto* presentation of of the medal shall be made later in the year at a time when many visiting scientists will be with us on account of various meetings to be held in connection with the exposition. Our statutes require that the medal shall be awarded at the annual meeting of the Society, and that the President shall set forth the reasons for the award. This medal is awarded, as you doubtless know, "for distinguished services to astronomy." In order, therefore, to keep within the law I hereby make public announcement of the award of the Bruce Gold Medal for the year 1915 to Dr. William Wallace Campbell, Director of the Lick Observatory, and give herewith the reason for this award by stating categorically that Dr. Campbell has "rendered distinguished services to astronomy." Undoubtedly at the presentation *de facto* (probably in August next) the details of these distinguished services will be given.

Having been deprived of this subject for a retiring address I have decided to present to you a brief review of the progress and development of astronomy during the year 1914. So very much is being done continually at the many observatories and by the numerous investigators that I cannot, in an address of this kind, hope to give an exhaustive account. I shall try merely to call your attention to the most important things that have been done and to astronomical phenomena that have taken place, cautioning you at the same time that there may be some important developments that I have inadvertently overlooked.

Nineteen hundred and fourteen presented us with five comets, four of which were new or unexpected. The first was discovered by Kritzinger, March 29th; the second by Zlatinsky,

May 16th; the third by NEUJMIN, June 24th; and the fourth, a naked-eye comet, independently by several observers on September 18th. It has been called Comet *e* 1914 (CAMPBELL) because this observer (at Arequipa, Peru) made the first announcement of the discovery. The fifth comet of the year (fourth in order of discovery) is Encke's Comet, which was picked up on this return by Dr. BARNARD on September 17th. This remarkable comet does not seem to have lost much if any of its brilliancy since its very first discovery. On November 16th it was reported as being of the sixth magnitude.

Of these comets, that discovered by NEUJMIN is the only one whose orbit deserves particular mention. This comet has the second largest perihelion distance (3.75 astronomical units) of any of the known comets. It is surpassed in this element by a comet of 1729, whose perihelion distance was 4.0 astronomical units. Both of these comets are moving in planes of high inclination and are probably of the same family of comets.

Definitive elements were published for two comets,, 1892 I (SWIFT) and 1898 VIII (CHASE).

The most important work concerning the Moon has been in the contributions to the theory of its motion by Professor E. W. BROWN of Yale. During the year he has presented several very valuable papers on this subject to the Royal Astronomical Society. The work on his new Tables of the Moon is nearing completion. On the observational side Professor RUSSELL of Princeton has contributed photographic determinations of the position of the Moon which give results "probably more accurate than any previous method of observation." Professor BROWN suggests a determination of the lunar parallax by a similar method.

An unusual phenomena connected with the Moon was the occultation of *Jupiter* visible on the Pacific Coast the evening of December 20th.

Steady progress was made during the year in the study of the Sun, but no epoch-making advance was made like HALE'S discovery, the previous year, of the fact that the Sun is a gigantic rotating magnet. The total eclipse of August 21st was observed in Russia by a few parties. Many of the best-equipped

expeditions were prevented from observing it on account of clouds.

Mercury made a transit across the disc of the Sun November 6th-7th. This was observed in many places. Besides noting the contact times, measures of the diameter of the planet were made at Greenwich.

Additions to the membership of the solar system were made as usual by the discovery of several new asteroids. Besides these a very interesting new member was discovered by Mr. NICHOLSON of the Berkeley Astronomical Department. Working with the Crossley reflector of the Lick Observatory on July 21st, he found a new moon revolving about *Jupiter*. This discovery of the Ninth Satellite of *Jupiter* marks the most important observational discovery of the year. From his own observations, using LEUSCHNER'S method, Mr. NICHOLSON computed the orbit of this new member of *Jupiter's* family. Its mean distance from the primary is 18,900,000 miles, the greatest distance from the primary of any of the satellites in the solar system. Like the Eighth Satellite, its motion is retrograde.

The most important contribution to the development of variable-star work has been the publication of the first installment of Father HAGEN'S Catalogue of Variable Stars. The accurate determination of stellar magnitudes by photo-electric photometry has continued to develop.

The work of the Astrographic Survey progressed at a satisfactory rate during the year. One of the chief difficulties in obtaining star places from photographic plates is the small number of comparison stars usually available. To overcome this Dr. SCHLESINGER has recently devised a method which is proving very efficient for cataloging stars by using a doublet of short focus, giving a good field over a large area. He finds the probable error of a position based upon four plates is less than $0''.18$. He is observing now the zone from $\delta = +2^\circ$ to $-2^\circ\ 10'$. The regions are being photographed in duplicate, the centers of one set of plates being upon the edges of others. In this way the mean of two positions of each star will depend upon fifteen comparison stars. Dr. SCHLESINGER writes: "It is hoped that this work may not only prove a valuable contribution to our knowledge of the positions and motions of faint

stars, but that it may enable astronomers to decide definitely as to the advantages and disadvantages of this form of instrument for wider applications of the same kind that the future will demand."

Several interesting investigations have been made concerning the number of stars and their light. From an examination of the Harvard Plates, Dr. HENIE, of Lund, concludes that the number of stars in the sky brighter than the eleventh magnitude is 1,013,328, or about 25 per square degree. His study shows that the region poorest in stars is in *Ursa Major,* where the average is only five per square degree, and that the richest region is in *Ophiuchus,* where the average is 112 per square degree.

Dr. S. CHAPMAN contributed an article to the *Monthly Notices* "On the Total Light of the Stars." From his work he concludes that the total light is equal about to 700 first-magnitude stars; or, putting it another way, equal to 1,750 stars like *Polaris* or to 60 stars like *Sirius.* Further, he finds that "half of the stars (several hundred million) give only one-fourth per cent of the total light, an amount equal approximately to that from four second-magnitude stars."

Adding to his important work on stellar drifts, KAPTEYN finds from a thoro study of the helium stars that nearly all of these stars in a great region of the southern sky from *Argo* to *Scorpio* and *Ophiuchus* are moving together relatively to the Sun. "They all appear to be drifting to a point 5° northwest of *Vega.*"

A piece of work that opens up a new field of investigation is that of Dr. COBLENTZ, of the Bureau of Standards, on the heat of the stars. Working with an apparatus he has devised, attached to the Crossley reflector of the Lick Observatory, last summer he succeeded in measuring heat radiations from stars as faint as the sixth magnitude. Among the interesting things he found is that "for the same visual brightness a yellow star sends us more heat than a white one, and a red star more than a yellow."

Of the work on the nebulæ, probably the most important contribution of the year was that made by Dr. SLIPHER in his discovery of the rotation in the Spindle Nebula in *Virgo,* N. G. C.

4594. Dr. WOLF had previously obtained evidence of rotation in the nebula M81. "These recent developments will be followed with great interest, as a study of internal motions in nebulæ must help considerably in the task of assigning to them their proper place in an ordered cosmogony."

KAPTEYN and others have heretofore shown that there is undoubted evidence of a general absorption of light in interstellar space. Recently Dr. BARNARD has brought forth convincing evidence of another kind of absorption in the investigation of the remarkable black spots in the Milky Way. He shows conclusively that such a spot is nothing else than an "opaque body in front of the star-cloud which hides part of it."

Along gravitational lines, Dr. BOTTLINGER, of Munich, presents an interesting paper on the absorption of gravitation. He attempts to show that gravitation is absorbed in traversing a medium. His opinion is that the attraction of the Sun for the Moon is enfeebled at the time of a lunar eclipse.

Probably the most valuable contribution to theoretical astronomy during the year is that of Dr. STRÖMGREN. This is an investigation of the perturbations of comets suspected of moving in hyperbolic orbits. He concludes that "there is no evidence that any comet pursues a hyperbolic path, except in so far as it has been perturbed by planets in its approach to the Sun." His researches appear to establish conclusively that the comets have their origin within the solar system. The most important part of his paper, however, is in the point that he makes and proves that in special perturbations the indirect terms due to the action of *Saturn* should always be taken into account.

In practical astronomy, the most interesting development has been in the determination of longitude thru the exchange of signals by wireless. A campaign for this purpose was carried on by the national observatories in Paris and Washington.

A new determination of the Constant of Aberration has been made by Dr. Ross, using his photographic zenith telescope at Gaithersburg. His value is 20″.495.

Advances have been made during the year in the way of large equipment. The building for the housing of the great 100-inch reflector on Mount Wilson is well under way. The mirror for the 72-inch reflector for the Canadian Government is in the

course of construction by BRASHEAR. A site for the observatory to house it has been secured near Victoria, B. C. The new 20-inch refractor for the Chabot Observatory of the city of Oakland, Cal., is well on its way toward completion. Wesleyan University has been furnished with the new Van Vleck Observatory, the principal instrument of which is an 18½-inch refractor.

New Zealand has been fortunate in the gift of £50,000 by Mr. CAWTHORNE to "ensure the proper equipment and support for the new Solar Physics Observatory at Nelson." Mr. CAWTHORNE had already endowed the observatory.

In speaking of instruments it may be of interest to note that Lord ROSSE's great 6-foot telescope has recently been presented to the Science Museum at South Kensington.

In 1914 the *Nautical Almanac and American Ephemeris* for 1916 appeared. This issue marks a decided advance in this and other similar publications. With this number is inaugurated the scheme of international co-operation adopted by the congress of representatives of the various national ephemerides held in Paris in 1911.

The great war has made itself felt in various ways in astronomy. Naturally, the number of foreign publications has been materially curtailed. Many scientists of the belligerent nations have left their instruments and gone to the front. The work of the international latitude observatories has been stopped in part, and the interruption of the whole work is quite possible. The meeting of the Astronomische Gesellschaft, planned to be held August 26th-29th in Russia was of course abandoned.

An event interesting to astronomers and mathematicians occurred July 24th and a few following days, when the Napier Tercentenary Celebration was held in Edinburg. Napier's famous "Logarithmus Canonis Mirifici Descriptio" was published in 1614.

The important medal awards of the year are: The Gold Medal of the Royal Astronomical Society to Professor M. WOLF, of Heidelberg, for his work in the region of celestial photography and spectroscopy; the Gold Medal of the Royal Society to Professor E. W. BROWN, of Yale, for his work on the motion of the Moon; the Bruce Gold Medal of the Astro-

nomical Society of the Pacific to Dr. O. BACKLUND, of Pulkowa, for his work on Encke's Comet and other investigations in theoretical astronomy; the Draper Medal of the National Academy to Professor JOEL STEBBINS, of the University of Illinois, in recognition of his work in the application of the selenium cell to celestial photometry.

Every year sees the passing of many prominent men of science and letters. Astronomy suffered severely in 1914 thru the death of two of its most eminent followers, Sir DAVID GILL and Dr. G. W. HILL, names worthy of a place along side of those of any time. In addition to these, 1914's death-roll includes the following prominent workers in astronomy: E. S. HOLDEN, the founder of this Society; R. LEHMANN-FILHÉS, C. F. PECHÜLE, N. C. DUNÉR, and WINSLOW UPTON. Sir DAVID and Dr. HILL were Bruce Gold Medallists.

In reviewing the work of the year, we find no striking discoveries as in some years, such as KAPTEYN'S star streams, or CAMPBELL'S that the velocities of the stars increase with their effective ages, or HALE'S that the Sun is a magnet. There is to be noted, however, a very healthy, steady progress along all lines.